Use of Waste Plastic with Bacterial Coating as a Sustainable Building Material in Concrete

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Abstract: The use of plastic is increasing day by day, although steps were taken to reduce its consumption. The suitability of recycled plastics shredded as coarse aggregate in concrete and its advantages are discussed here. Tests were conducted to determine the properties of plastic aggregate density, specific gravity and aggregate crushing value. As 100% replacement of natural coarse aggregate (NCA) with shredded plastic is not feasible, partial replacement at various percentage were examined. Higher compressive strength was found with 5% NCA replaced concrete.

***IndexTerms*- shredded plastic, bacillus subtitlus bacteria, tests etc.**

I. INTRODUCTION

Landfill sites are becoming overcrowded and expensive for waste disposal, efforts are madeto minimize the quantities of materials that are delivered to landfills. The threat due to leaching of non-biodegradable materials like waste plastics, scrap tyres. If the production of waste cannot be prevented, then itis attractive to create an alternative use in another process instead of disposal. The benefits ofplastic recycling can be economically advantageous, due to abundant availability lower cost for mixing with other variants like concrete, bitumen etc. The project aims at use of recycled plastic in concrete as a partial replacement of Coarse aggregate. The maximum percentage of aggregate replaced by shredded plastic as been determined based on detailed experimental study. The waste plastic of LDPE (Low density 2 poly Ethylene) is collected from Gadhinglaj southwest localities and mixed with OPC. The compressive strength for each variant is determined in laboratory.

II. Objectives-

1. To compare the compressive strength and density of recycled shredded plastic used as coarse aggregate for constructional concrete with the conventional concrete.
2. To reduce the pressure on naturally availability materials by replacing it with Shredded Recycled plastic.
3. To compare the physical characteristics of natural aggregate with Shredded Plastic.
4. To study the behavior of fresh and hardened concrete with Shredded waste plastic as aggregate and compare its properties to those of conventional concrete
5. To produce lightweight concrete for multi-purpose use.

III. Literature Survey

They have investigated the suitability of recycled plastic as partial replacement to coarse aggregate in concrete mix to study effect on compressive strength, modulus of elasticity, split tensile strength and flexural strength properties of concrete. Coarse aggregatefrom plastic was obtained by Shredding the plastic pieces at required sizes and crushed to required size of aggregate. Their experimental results shown that plastic aggregate have low crushing (2.0 as compare to 28 for Natural aggregate), low specific gravity (0.9 as compare to 2.74 for Natural aggregate), and density value (0.81 as compare to 3.14 for Natural aggregate), as compare to Natural coarse aggregate. Their test results were based on 5% substitution of natural coarse aggregate with shredded plastic. Increase in workability was reported when slump test for sample was carried out. Volumetric substitution of natural aggregate with plastic aggregate was selected best in comparison with grade substitution. At 400 centigrade temperature Shredded Plastic aggregate shown considerable decrease in strength as compare to normal concrete. An increase of 28% was observed in compressive strength but decrease in split tensile strength and modulus of elasticity was observed.

IV. Study of Materials

Cement

Shredded Plastic

Fine Aggregate

Bacillus subtilis

Water

4.1 Cement-

Concrete is a homogeneous mixture of cement, sand, aggregate and water in proper proportion.

Concrete is composite construction material composed of aggregate, cement andwater formulation that have varied properties. The aggregate is generally course gravels or crushed rocks such as limestone, or granite, along with a fine aggregate such as a sand. The cement, commonly Portland cement and other Cementous materials such as fly ash, slag cement, granulated glass farness slag (GRANULATED GROUND FURNACE SLAG),serve as a binder for aggregate. various admixture to be added to achieve various properties.Water is then mixed with this dry composite which enables to be shaped (typically poured) and then solidified and hardened into rock-hard strength through a chemical process is known as hydration. The water reacts with the cement which bonds the other component together, eventually creating a robust stone like material. Concrete has relatively high compressive strength, but much lower tensile strength. For this reason, is usually reinforced with materials that are going to strong in tension (often steel).

Concrete has been damaged by many processes, such as freezing of trapped water concrete is widely used for making architectural structures, foundations, brick/block walls, pavements, bridges/overpasses, motorways/road, runways, parking structures, dams, pools/reservoirs, pipes, footing of gates, fences and poles and even boats.

Famous concrete structures include Bud Khalifa (world's tallest building ever), the Hoover Darn, the Panama Canal and Roman Pantheon. There are many types of concrete available, created by varying the properties of the main ingredients below. In this way or by substitution for the cementations and aggregate phases, the finished product can be tailored to its application with varying strength, density, or chemical and thermal resistance properties.

4.2 Shredded Plastic-

Plastics collected from the disposal area were sorted to get the superior one. These were crushed into small fraction and washed to remove the foreign particles. Then it was shredded at a particular size so that the necessary brittleness was obtained. After extrusion the shredded plastic was cooled down and collected in sizes of 100 mm size approximately. Properties According to the Indian standard specifications the property of aggregates such as specific gravity, aggregate Impact value and density were determined. From (Table 1) comparing the properties of aggregate for both NCA and Shredded Plastic it is observed that the specific gravity and density for shredded plastic is much lower than NCA which offers a light weight concrete. A lower crushing value indicates the complexity with which a shredded plastic concrete couldbe crushed under compressive stresses.

"Figure no-1". Shredded Plastic Aggregate

4.2.1 Properties of shredded plastic:

Table.no-1 Properties of shredded plastic

Sr.No.	Property	Average value
1.	Density	0.81kg/m3
2.	Impact value	4.54%
3.	Abrasion value	9.54%
4.	Specific gravity	1.06
5.	Water absorption	5%
6.	Melting point	75-100 C

4.3 Bacillus subtilis-

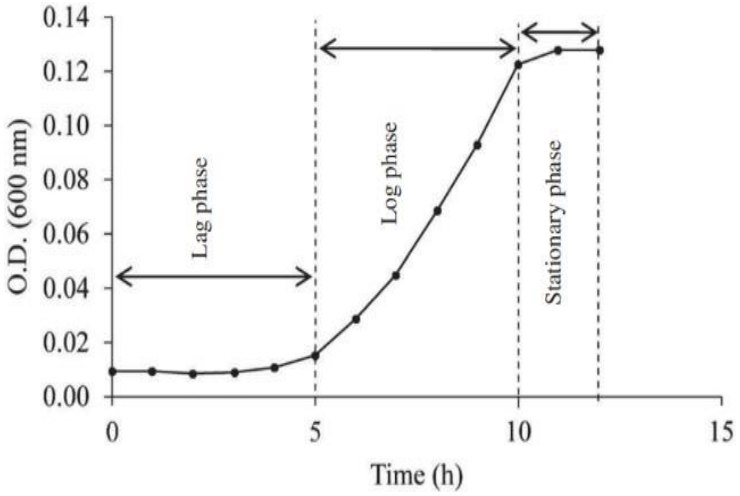
Due to rapid construction, necessity for raw materials of concrete, especially coarse aggregate, tends to increase the danger of early exhaustion of the natural resources. An alternative source of raw materials would perhaps delay the advent of this early exhaustion. Recycled shredded plastic coarse aggregate (RSPCA) plays a great role as an alternative raw material that can replace the natural coarse aggregate (NCA) for concrete. Previous studies show that the properties of RSPCA concrete are inferior in quality compared to NCA concrete. This article attempts to study the improvement of properties of RCA concrete with the addition of bacteria named as Bacillus subtilis. The experimental investigation was carried out to evaluate the improvement of the compressive strength, capillary water absorption, and drying shrinkage of RSPCA concrete incorporating bacteria. The compressive strength of RSPCA concrete is found to be increased by about 10% when the cell concentration B. subtilis is 106 cells/ml. The capillary water absorption as well as drying shrinkage of RCA are reduced when bacteria is incorporated. The improvement of RCA concrete is confirmed to be due to the calcium carbonate precipitation as observed from the microstructure studies carried out on it such as EDX, SEM, and XRD.

Experimental investigation

Culture of Bacillus subtilis B. subtilis (MTCC.736), which facilitates the precipitation of calcium carbonate, was collected from the National chemical laboratory pune, India, and was constantly maintained on nutrient agar slant. A single colony of the culture was taken and inoculated into nutrient broth and incubated at 37°C with constant shaking at 150 rpm. The medium composition of nutrient broth used for routine culture shown in **fig.2**

Table no -2. Cultures of Bacteria

Medium composition for bacteria	Composition amount [g/l)
Peptone	5
Nacl	5
Yeast extract	3
Urea	20
Calcium chloride	15
NH4Cl	2



"Figure no-2" Growth curve of Bacillus Subtilis

Compressive strengths of bacteria-

The addition of bacteria to the fresh concrete results in the formation of CaCO3 precipitation that can be observed through the naked eye bacterial RCA concrete with a concentration of 106 cells/ml, and RCA and NCA concrete without bacteria, respectively. A white foam like material can be visualized on the outer surface of the bacterial concrete sample. The mean compressive strengths of specimens with different concentrations of bacteria after curing of 7 and 28 days are presented in **Table no 4.**

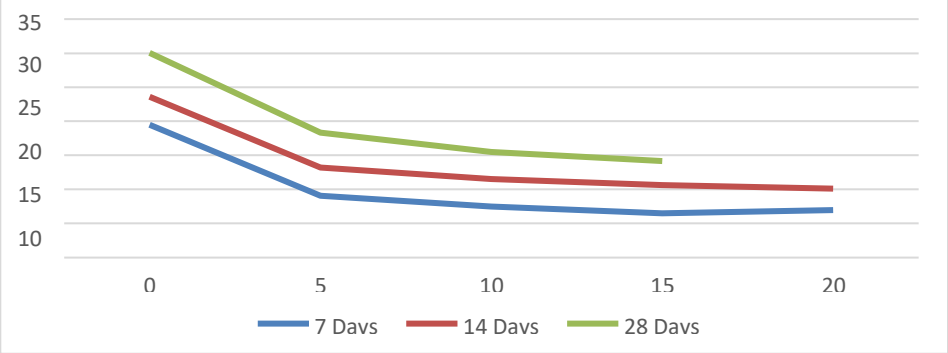
V. Methodology-

The successive steps that were followed to complete the study were as follows: Preparation of recycled shredded plastic. Various tests were conducted on cement, and coarse aggregate to determine its physical properties Test on Cement: Specific gravity, standard consistency, initial and final setting time, compressive strength of mortar cube. Test on aggregates: Specific gravity, sieve analysis. Mix design of M25 grade concrete. Cubes, were casted with control mix using natural aggregate for varying percentage replacement (0,5,10,15,20) of natural aggregate by shredded plastic. Workability, compressive strength of concrete where conducted. Optimum percentage of shredded plastic that can be replaced in concrete was determined.

VI. Compressive strength-

Table no -3. Replacement of shredded plastic

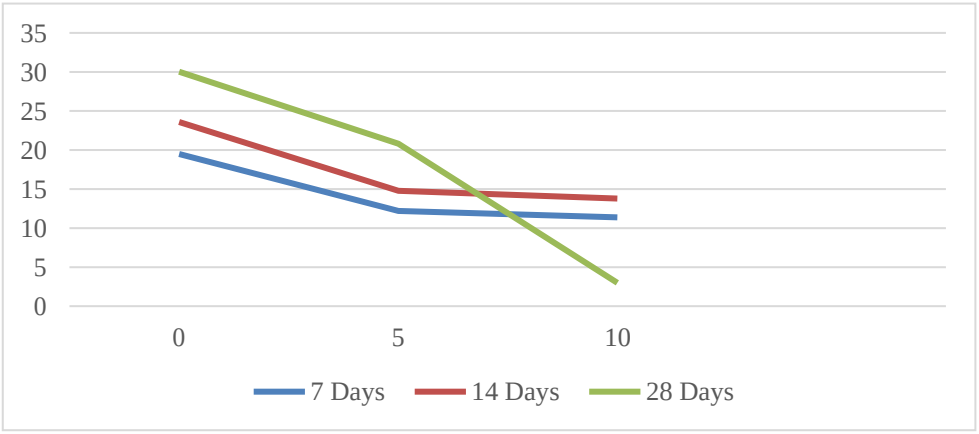
% of Aggregate replaced	7 Days	14 Days	28 Days
0%	19.5	23.6	30.04
5%	9.08	13.20	18.31
10%	7.51	11.5	15.47
15%	6.5	10.62	14.15
20%	7	10.11	12.33



Graph no-1.
Compressive strength

Table no-4.
Replacement of shredded plastic with bacterial coating

% of Aggregate replaced with Bacterial coating	7 Days	14 Days	28 Days
0%	19.5	23.6	30.04
5%	12.20	14.80	20.82
10%	11.40	13.80	19.20



Graph no-2 Compressive strength for bacterial coating

VII. Discussion-

Thanks to new features to these materials present innovative technical solutions,semi-natural and ecological, for traditional construction problems allowing world wide of application in construction, architecture, decorative and even furniture.

7.1 Applications-

[1] Used as for construction of partion wall.

[2] Used for the construction of Pavement block.

[3] Used for the construction of compound wall.

VIII. Conclusion-

[1] As percentage of plastic increases workability also increases because the plastic which is used as aggregate is smooth. As well as water absorption capacity of plastic is also low.

[2] The modified concrete mix, with addition of plastic aggregate replacing conventional aggregate up to certain 5% gives strength with in permissible limit.

[3] The flexural strength at each curing age is prone to decrease with the increase of the waste plastic and aggregate ratio. This trend can be attributed to the decrease in adhesive strength between the surface of waste plastic particles and the cement paste.

[4] The density of concrete decreased when plastic content increased.

[5] Because plastic has more water tightness capacity when compared to natural aggregate thiscan help in arresting micro cracks.

[6] By using recycled shredded waste plastic in concrete can reduce the land fill and environmental issues.

[7] Shredded Plastic aggregate is a lightweight material with specific gravity 0.94.

[8] By using plastic shredded aggregate we cannot use it for structural construction.

IX. References-

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